

We claim:

- 1 1. A semiconductor resonator structure comprising:
2 a light transmissive substrate;
3 a guiding channel defined in the substrate; and
4 at least two distributed gratings defined in the substrate surrounding the
5 guiding channel by at least two opposing sides of the guiding channel, wherein
6 either the period of each of the gratings or their refractive index or both are not
7 constant.
- 1 2. The structure of claim 1 wherein the channel has an external side and an
2 internal side and where the gratings disposed on the external and internal sides
3 are different.
- 1 3. The structure of claim 1 wherein the gratings have an index profile given
2 by $n(\rho) = n_{eq}(\rho) R / \rho$ and $n_{eq}(\rho = R \exp(U/R))$ has a conventional Bragg grating
3 index profile, where ρ is the radial polar coordinate, $n(\rho)$ is the real index of
4 refraction as a function of ρ , $n_{eq}(\rho)$ is the equivalent index of refraction as a
5 function of ρ , U is a transformational coordinate given by $\rho = R \exp(U/R)$, and R
6 is an arbitrary constant.

- 1 4. The structure of claim 1 wherein the gratings are Bragg gratings
2 comprised of layers with a width, $w = u_2 - u_1$, determined according to

3
$$\frac{\pi}{2} = \int_{u_1}^{u_2} \sqrt{k_0^2 n_{eq}(u)^2 - m^2 / R^2} \cdot du$$

- 4 where ρ is the radial polar coordinate shown as the integration variable u above,
5 k_0 is the wave number in vacuum of the light propagating in the structure, $n_{eq}(\rho)$
6 is the equivalent index of refraction as a function of ρ , m is a predetermined
7 azimuthal number, R is the radius of the internal edge of the grating, u_1 and u_2
8 are respectively the initial and end radii of a Bragg layer in the grating.

- 1 5. The structure of claim 1 wherein the shape of the resonator is circular.

- 1 6. The structure of claim 1 wherein the shape of the resonator is oval.

- 1 7. The structure of claim 1 wherein the index of refraction of the guiding core
2 is smaller than the index of refraction of the surrounding distributed gratings.

1 8. The structure of claim 2 wherein the index of refraction of the guiding core
2 is smaller than the index of refraction of the surrounding distributed gratings.

1 9. The structure of claim 1 wherein the distributed gratings are made of
2 dielectric material.

1 10. The structure of claim 1 wherein at least part of the substrate is "active"
2 and able to provide optical gain.

1 11. The structure of claim 1 wherein the distributed gratings are comprised of
2 alternating index layers.

1 12. An optical resonator with large free spectral range (FSR) and low losses
2 comprising:

3 an optical substrate;

4 a guiding channel defined in the substrate; and

5 at least one radial Bragg reflector adjacent to the guiding channel to
6 confine light therein.

1 13. The optical resonator of claim 12 where the guiding channel and adjacent
2 radial Bragg reflector form a combination with radial structure, is a combination
3 characterized by a profile of the refractive index, which profile is a periodic
4 function superimposed on a decreasing function of radial position.

1 14. The optical resonator of claim 13 where the Bragg reflector is comprised
2 of a plurality of radial layers having a distinct refractive index from the refractive
3 index of the substrate, where the plurality of radial layers have an internal edge,
4 and where the width of each layer is selected so that constructive interference of
5 all partial reflections from the plurality of layers is obtained at the internal edge of
6 the Bragg reflector.

1 15. The optical resonator of claim 14 where the optical resonator has a
2 resonant frequency of light, where each layer of the Bragg reflector has a
3 thickness and where the thickness of each layer is greater than the constant
4 Bragg thickness for reflector at the resonant frequency of light and decreases
5 asymptotically toward the constant Bragg thickness as the distance of the layer
6 away from the guiding channel increases.

1 16. The structure of claim 15 wherein the thickness of each layers is $w = u_2 -$
2 u_1 , determined according to

$$\frac{\pi}{2} = \int_{u_1}^{u_2} \sqrt{k_0^2 n_{eq}(u)^2 - m^2 / R^2} \cdot du$$

3

4 where ρ is the radial polar coordinate shown as the integration variable u above,
 5 k_0 is the wave number in vacuum of the light propagating in the structure, $n_{eq}(\rho)$
 6 is the equivalent index of refraction as a function of ρ , m is a predetermined
 7 azimuthal number, R is the radius of the internal edge of the grating, u_1 and u_2
 8 are respectively the initial and end radii of a Bragg layer in the grating.

1 17. The optical resonator of claim 12 where the guiding channel is
 2 characterized by a low index of refraction.

1 18. The optical resonator of claim 12 where the guiding channel forms a
 2 closed loop.

1 19. The optical resonator of claim 12 where the guiding channel has an
 2 external side and an internal side, and where the at least one radial Bragg
 3 reflector is comprised of at least two radial Bragg reflectors, a first one of the two
 4 radial Bragg reflectors is disposed on the external side of the guiding channel

5 and adjacent thereto and a second one of the two radial Bragg reflectors is
6 disposed on the internal side of the guiding channel and adjacent thereto.

1 20. The optical resonator of claim 12 further comprising means for pumping
2 the guiding channel.